Cohort, Age and Year Effects on Italian Household Consumption

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1. Introduction

The evolution of the structure of Italian population is well known in its characteristic features: zero growth, population ageing and high immigration. Several models exist to estimate the impact of these features on different areas of the economy. The work presented in this paper focuses mainly on the effect of population ageing on consumer spending, although there are other possible economic influences of demographic evolution, such as effects on labour markets and on the government budget.

The INFORUM approach to personal consumption expenditure modelling has been described in a number of papers.[2] It is a two-stage approach with a cross-section/time-series analysis and a linkage between the two. The demand system is estimated over a 40-item classification of goods and services. All these modules are designed to be included in a macroeconomic interindustry model of Italy.[3]

The effect on household consumption of the age structure of the population is accounted for with an adult equivalency weights scheme in the cross-section function, as described in Appendix A. Then, the estimated weights are used to construct a time series of weighted populations which embodies the age effect on household expenditure and it is used to estimate

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[2] See Almon (1979, 1996), Bardazzi and Barnabani (1998, 2001), Chao (1991), Grassini (1983), and Dowd *et al.* (1998).

[3] This is Intimo (Interindustry Italian Model) which is part of the INFORUM system (Interindustry Forecasting Project University of Maryland). Its fundamental features are described in a recent paper by the builder (Grassini, 2001).

and forecast the demand system of Italian personal consumption.

A problem arises in the interpretation of the age effects estimated through this procedure. The adult equivalency weights do not represent a 'pure' influence of age in consumption choices, instead they include an age effect, that is the characteristic life-cycle profile of consumption, and a cohort effect, that leads to differences in the positions of age profiles for different cohorts. The weights are estimated from a time series of cross-section data where we are not looking across ages for the same cohort of households, but at the experience at different ages of different groups of households. Moreover, all cohorts may be affected by macro shocks, that is aggregate effects that synchronously but temporarily move all cohorts off their profiles. These year (time) effects should also be considered.

In a cross-section one cannot identify both age and cohort effects, while repeated cross-sections allow the researcher to track cohorts over time. In this paper, we use cross-sections on household consumption from 1985 to 1996 to construct cohort data. Then, we analyse how relevant is the interaction of age and cohort effects on disaggregated household consumption by applying a decomposition between cohort, age and year effects presented by Deaton and Paxson (1994). This procedure assumes that the time effects reflect additive macroeconomic shocks that sum to zero and are orthogonal to a time trend. We present results for a selection of commodities in our 40-item classification and we conclude that most of them follow the model proposed with the hypothesis of constrained time effects. The decomposition show significant differences on the shape of age and cohort effects. The age profile is decreasing for food and tobacco, increasing for technical instruments and financial services, hump shaped for alcoholic beverages. Cohort effects are increasing for food and tobacco, decreasing for technical instruments and financial services, with no distinctive pattern for alcoholic beverages. The main findings of this study is that cohort effects need to be distinguished from age effects because for many items they are relevant and with distinctive patterns. Therefore, their presence should affect the personal consumption expenditure modelling and not being confused with a 'pure' age effect in forecasting

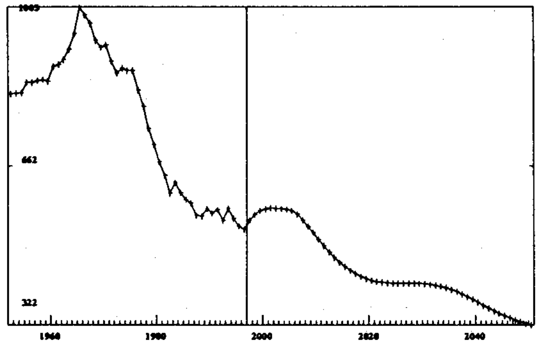
2. Population ageing and personal consumption expenditure

The main characteristics of Italian population evolution are widely known: zero growth, population ageing and high immigration to compensate the decrease of national population.[4] A Demographic Projections Model (*DPM*) for Italy has been built, based upon the "*cohort component method*" to project population by age into the future with the assumption of specific hypotheses about mortality rates, fertility rates and net immigration.[5] In the following, we will use the results obtained from this model to describe the future structure of Italian population up to 2050: demographic projections of our model mimic very closely those produced by the Italian National Office of Statistics (ISTAT).

As many other developed countries, in the Sixties Italy experienced a relevant increase of births. In particular, births increased sharply from 1956 to 1968 due to a rise of the total fertility rate from 2.38 in 1959 to 2.7 in 1964. Therefore this baby boom was explained by a high fertility rate while the increase of births registered during the period 1996-2000 is due to the entry of the baby boom generation in the most fertile age.[6]

Births

(Thousands)



[4] Many works regarding the quantitative analysis of these demographic trends have been published. See, among others, Golini (1994), Golini *et al.* (1995), IRP (1999).

[5] This demographic model is described in Appendix B, at the end of the paper.

[6] We remind here that the beginning of fecund age has been moved forward in women lifetime, therefore the births increase is at present in progress.

These two events characterise the age composition of the population as a two-peak distribution. Then, a negative trend is estimated until the end of the forecast horizon with a slowdown during the decade 2020-2030 due to the birth of grandchildren of the same generation. We point out that the increase in the total fertility rate does not contradict the hypothesis of a decrease of fertility: here we are talking about the per period TFT and not the cohort fertility rate. This rate shows an increase because of the partial recovery, for 30 year-olds, of fertility not realised in their youth.

The analysis of the age composition of the Italian population presents some relevant changes that could deeply influence the Italian economy in several ways. Table 1 shows the impact of the baby boom cohort from the 1960s on the population age composition: the increase of 0-9 cohort in 1960 and 1970 runs progressively down the diagonal of the table, this generation is currently part of the 30-39 and 40-49 age groups and will begin to enlarge the rows of over 60 by 2030, to enter the group of over 75 at the end of our forecast horizon.

The age composition of the population influences the labour force growth: in 1960, 54 percent of the population was aged between 20 and 60 (working age), then as the baby boom cohort ages, this share at first diminishes then rises between the years 1990 and 2000. From the beginning of the new century the percentage of population between 20 and 60 years old decreases to reach the 45 percent of the population by 2050 (assuming fixed labour force participation rates).

Table 1

Age Structure of the Population 1960-2050

	Shares of population in age groups (%)								
Year	0-9	10-19	20-29	30-39	40-49	50-59	>60	>75	20-60
1960	16.3	16.1	15.8	15.3	11.9	11.2	13.5	3.1	54.1
1970	17.1	14.7	14.2	14.1	13.6	10.3	15.9	3.7	52.2
1980	14.3	16.3	13.8	13.3	13.1	12.3	16.8	4.5	52.6
1990	10.3	14.2	16.0	13.6	13.0	12.4	20.4	6.5	55.0
2000	9.6	10.2	14.2	16.0	13.4	12.5	24.0	8.0	56.2
2010	9.5	9.7	10.3	14.4	15.9	13.0	27.1	10.4	53.7
2020	7.9	9.9	10.1	10.9	14.8	16.0	30.4	12.1	51.8
2030	7.6	8.4	10.5	10.9	11.5	15.1	35.9	14.0	48.1
2040	7.8	8.2	9.2	11.6	11.7	12.0	39.5	16.6	44.5
2050	7.3	8.6	9.3	10.5	12.7	12.5	39.1	19.9	45.0

Source: 1960, Istat; other years, authors' calculations.

The age structure of the population has other impacts, which are the main interest for this study: the composition of consumer spending. People of different ages tend to consume different goods and services; therefore, the population ageing will change the structure of demand. This may affect productive sectors differently, with winners and losers. This in turn will change the output composition and the employment patterns.

In a previous study of Italian household consumption, we have applied a cross-section function, fully described in Appendix A, over a 40-item classification of expenditures. In that function, the household consumption is estimated using, among other variables, the weighted sum of family members. These adult equivalency weights show the importance of the household members in different age groups relative to an adult aged 30-39 - whose weight is equal to one - in contributing to the consumption of a specific item. A first descriptive use of these parameters is the following. We can combine the population by age groups computed by the DPM and the appropriate adult equivalency weights to construct a time series of weighted populations specific for each commodity.

A weighted population time series for a commodity i, WPOP, is defined by:

$$WPOP_{it} = \sum_{j=1}^{g} N_{jt} w_{jt}$$

where N_{jt} is the number of individuals in age group j in year t and w_{jt} is the weight assigned to each specific age group. The commodity specific weighted populations allow assessing either that the age structure of the population is important to the determination of consumption and that the shifts through time in the relative sizes of age groups are significant.

Following Dowd *et al.* (1998), we may use the weighted populations to analyse the impact of population age composition on consumption, by forming an index defined as following:

$$100 * (WPOP_i / POP) * (POP95/WPOP_i 95) - 100$$

where $WPOP_i$ is the commodity specific weighted population and POP is the total population. This index shows the percent difference from 1995 in real per-capita consumer spending due to changes in the age composition of the population. We must stress that this measure is calculated with relative prices and consumer preferences being constant. Following this approach, we have computed a series of commodity specific indexes for Italy. Some results for a selection of the 40-item classification is presented in Table 2 along with some aggregations of the indexes by using fixed 1995 consumption shares.

Table 2

Real Per-Capita Consumer Spending Changes Due to Age Composition Evolution

	Percentage change relative to 1995=0						
	1985	2000	2010	2020	2030	2040	2050
Average age of population	36.6	40.9	43.2	45.5	47.4	48.6	49.2
Durable Goods	0.54	-0.08	-0.17	-0.36	-0.47	-0.44	-0.48
Vehicles	7.38	-2.80	-6.34	-9.07	-10.86	-12.11	-12.72
Orthopaedic Equipment	-3.06	5.04	10.70	13.13	15.68	19.52	20.47
Semi-Durable Goods	-0.51	0.03	-0.07	-0.22	-0.28	-0.37	-0.37
Clothing	-2.12	-0.08	-0.76	-1.42	-1.70	-1.87	-1.79
Operation of Vehicles	-2.41	-0.19	-1.47	-2.93	-3.62	-4.68	-4.92
Non-Durable Goods	-0.40	0.23	0.54	0.76	0.93	1.03	1.05
Electricity, Oil and Gas	-2.23	2.08	5.52	7.83	9.27	10.90	11.25
Drug Preparation	-4.45	2.78	4.69	7.13	10.17	11.61	11.51
Services	-0.95	0.31	0.68	1.08	1.34	1.50	1.60
Domestic Services	-0.77	1.38	5.37	8.67	9.46	9.80	10.18
Medical Services	-4.53	1.58	5.22	7.77	8.29	9.06	9.88
Hospitals, Nursing Homes	-3.05	5.04	10.69	13.13	15.68	19.52	20.46
Education	6.00	-4.82	-6.85	-5.95	-8.85	-11.76	-10.96

Source: authors' calculations.
Note: Holding income and prices constant, a value of 1 indicates that real per-capita spending is up 1 percent relative to 1995

At a first glance, this table confirms expectations about the foreseeable effects on consumer spending due to the population ageing, but the indexes of durables, semi-durables, non-durables and services do not show significant variations from 1995 as was found with the same analysis about US spending. However, a closer look at the commodity specific indexes reveals very useful information for explaining the result of the aggregate indexes. For instance, among durable goods, the purchase of motorvehicles shows a decrease of –10.86 percent in 2030, but this variation is compensated inside the aggregate by the opposite change of orthopaedic equipment (+15.68 percent). We may observe the same opposite dynamics among services, namely with domestics services and education: housing expenses, along with electricity, oil and gas purchases, medical services and pharmaceutical products are the most significant effects due to the ageing population.

The analysis based upon these indexes does not consider variations of income, prices and preferences. The weighted population series is constructed from the adult equivalent weights: these weights vary from 1985 to 1996 because they are estimated from the cross-section data, but they are fixed at their 1996 value for the period 1997-2050. This means that, for instance, if the elderly in 1996 have a consumption of wine greater than the young people the index of alcoholic beverages will show an increase in the future because of the ageing population. This evolution would be inconsistent with the historical trend of this commodity, which is showing a constant diminishing trend. In fact, we may think that the present young generation will age with its actual preferences and will not adjust to the elderly behaviour of today. This argument is valid for all commodities but particularly for some of them such as fats and oils, tobacco, alcoholic beverages, financial services, technical instruments. In these cases, we may observe a remarkable change of habits given to health reasons, technological progress and other causes: it's hard to believe in a backward involution.

These considerations suggest that what we consider an age effect on consumption, estimated by the equivalency weights, may be something more, that is a compound effect of age and generation.

3. Consumption profiles: life cycle and generations

The main point here is to distinguish between a pure age effect and a cohort effect on consumption. The cohort effects prohibit considering a cross-sectional consumption profile as a life-cycle age-related profile. In fact, the consumption behaviour includes an age effect, that is the characteristic life-cycle profile of the variable, and a cohort effect that leads to differences in the positions of age profiles for different cohorts. If these differences exist, it is not correct to extrapolate from cross-sectional data information about the life-cycle consumption of an individual household. The economic analysis based upon survey data has its advantages because of the wide variety of household characteristics in the

sample. It has limits because we are not looking across ages for the same cohort of households, but at the experience at different ages of different groups of households. However, with a time series of cross sections, though there is no possibility of following the same households over time since different households are selected in each survey, it is still possible to follow cohorts of people from one survey to another. Tracking different cohorts through successive surveys allows us to disentangle the generational from the life-cycle components in consumption profiles. In order to do this, we need to construct cohort data. These semi-aggregated data provide a link between the microeconomic household-level data and the macroeconomic data from national accounts. There are some disadvantages of cohort methods. First of all, we assume that the cohort population is constant:[7] this causes problems with migration, ageing and death. But more serious difficulties come when data are collected only at the household level and we are forced to define cohorts of households by the age of the head. This choice create problems because households are not permanent, they change with divorces, remarriages, older people who go to live with their children. Therefore, old household in some surveys may become young households in others.

It is possible to use these cohort data to apply a decomposition into age effects, cohort effects, and year effects. This technique is commonly used to test the life-cycle theory of consumption.[8] Here, since in our surveys there are not good data on income, we use this decomposition simply as a descriptive device to verify our idea of an age and a cohort effect interacting in our data.

The data set used in this work is the Survey of Family Budgets published by the Italian Statistical Office (ISTAT). The survey is structured as a repeated cross-section. Altogether some 32,000 households are sampled throughout the year.[9] This paper uses observations for the period 1985-1996, after this year the survey design has been changed and the series is not homogeneous.

We can present these data in different ways. Figure 1 shows the cross-sectional age profile of (constant-price) consumption for 1985, 1991,

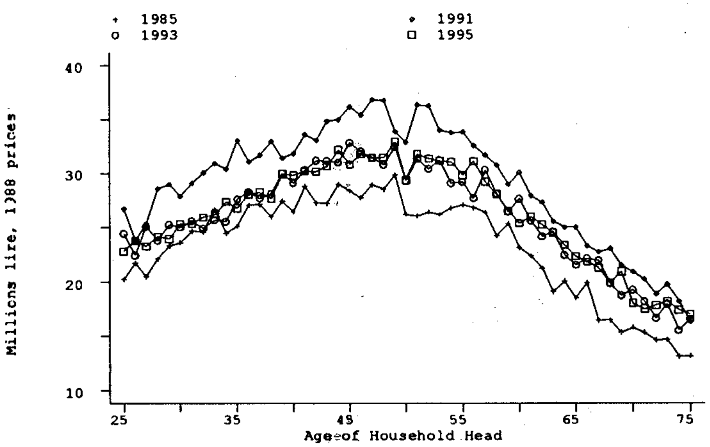
[7] "An assumption that is needed if the successive surveys are to generate random samples from the same underlying population". Deaton (1997), p.121.

[8] See Deaton and Paxson (1994), Jappelli (1999), Jappelli and Modigliani (1998).

[9] The sample size has been sharply reduced in 1996 with 22,740 households in the survey.

1993 and 1995. Each curve plots against head's age the average consumption of all households with heads of that age.

Figure 1



Cross-sectional consumption profiles, selected years

The growth of real consumption has raised these profiles from 1985 to 1991.[10] The 1993 negative macroeconomic shock with the accompanying lira devaluation has implied a fall of personal consumption expenditures, so the 1993 and 1995 consumption profiles are not far apart but below the one of 1991. The age profiles rise somewhat from age 25 through 50, and decline thereafter. However, these profiles tell us nothing about the experience of any given cohort. To trace the average consumption of each generation the points should be connected not within years but within cohorts: the age profile from a single cross section confounds the age effects with the generational effects.

[10] The years 1986-1990 missing in the figure have plots raising above the 1985 and below the 1991 curves.

4. Cohort Data

An alternative representation is obtained with cohort data. Cohorts are constructed by date of birth of the household head, or more conveniently, by age in 1985. For each survey, we average the expenditures by age of head and then track the sample from the same cohort one year older in the next survey. For example, we can look at the average consumption of 30-year-olds in the 1985 survey, of 31-year-olds in the 1986 survey and so on. We have constructed (and will use) the cohorts at each age, but in the following table and graph we show numbers only for a selection of them (every fifth cohort). Table 3 presents cohort definition, average cell size and average consumption. The table reveals that average cell size is lower for the youngest (1) and the oldest (9) cohorts. Year-by-year cell-size information shows that cohort 1 has a strong upward trend in cell size, while cohort 9 exhibits a decline up to 1996.[11] The explanation for the youngest cohort is simply that 36-year-olds are much more likely to be household heads than 25-year-olds. For the older cohort, mortality may be the cause of the cell size decrease over time. For the middle years of household headship, the variation in sample size is much less, both because there are more households and because the selection problems are less severe.

Table 3 Selected Cohorts Definition and Average Consumption

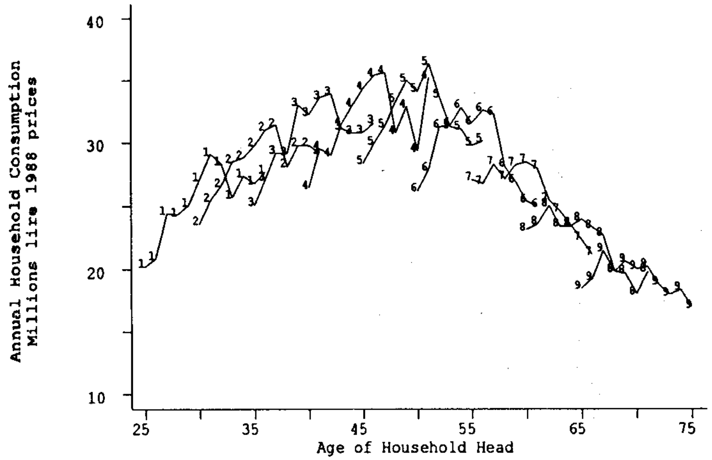
Cohort	Year of Birth	Age of Cohort in 1985	Age of Cohort in 1996	Average Cell Size	Average Consumption
1	1960	25	36	541	25.574
2	1955	30	41	671	28.520
3	1950	35	46	758	30.634
4	1945	40	51	648	31.920
5	1940	45	56	794	32.007
6	1935	50	61	705	29.275
7	1930	55	66	745	25.916
8	1925	60	71	670	22.165
9	1920	65	76	589	19.290

Note: (Annual) Average consumption is expressed in millions of 1988 lire.

[11] Cell sizes for the year 1996 are substantially lower for all cohorts given the reduced sample size.

Figure 2 shows the cohort consumption beginning with those born in 1960. The first line segment -labelled with number 1- connects the average consumption of those who where 25 years old in 1985 to the average consumption of 26 years old in 1986, until the last observation of the cohort in 1996, when they were 36 years old. The second line segment repeats the exercise for those who were five years older until the last cohort considered in this graph of those born in 1920, labelled with number 9.

Figure 2



Total household consumption, by age of household head

There is a visible life-cycle pattern, rising with age and then falling with a peak around the age of 50. With few exceptions at older ages, the lines for the younger cohorts are very often but not always above the lines for the older cohorts, even when they are observed at the same age, that is when the cohorts overlap. This is because the growth at the end of the 80's made the younger generations better-off.

This is the cohort effect. We noticed that the younger cohorts tend to have a higher average consumption than the older but this is not always the case. In fact, there is also a great deal of within-cohort movements. We

think that some of them may be explained by a common macroeconomic shock that is perhaps the hardest to see in this graph. Note that each connected line segment corresponds to the same contemporaneous span of 12 years, 1985-96. Each cohort, except those born before 1930, has a constant growth of average consumption from 1985 to 1991, a slowdown in 1992, then a clear fall in 1993 and a very modest growth after that. This is an example of year effect, that is an aggregate effect that synchronously but temporarily move all cohorts off their profiles, in this case a fall of the economy growth rate.

A deeper analysis of this figure requires us to distinguish these three effects: age, cohort, and year effects. In order to do this, we need to construct cohort data and to separate these three components. The data were constructed according to the principles outlined above. We have constructed cohorts at each age although we have eliminated the youngest and the oldest groups (below 25 and above 75 years old). We have truncated on age of head, eliminating those below 25 because there were very few household heads so young, and those above 75 to avoid a selectivity problem. We end up with 62 cohorts: the youngest of those 25 years old in 1996, the oldest of the 75-year-olds in 1985. We have, for each commodity, a stacked vector of cohort-year observations on the cohort means of consumption.[12] We have decided to construct cohort data not only for the aggregate consumption but also for the 40 expenditure categories of our model. This is because we are interested in verifying how relevant are the age and cohort effects for some commodities of our classification.

5. Age, cohort and year effects: a decomposition

In order to estimate the decomposition of effects, we may regress the cohort averages of consumption against dummy variables for all three sets of effects. Of course other restrictions could be used such as polynomials, but when data are plentiful we can use dummy variables and thus allow the data to choose any pattern. The model can be written as

$$y = \beta + A\alpha + C\gamma + Y\psi + u$$

[12] In fact, we have worked with the means of the logarithm of consumption.

where y is the stacked vector of observations, A is a matrix of age dummies, C a matrix of cohort dummies, and Y a matrix of year dummies.[13]

We must drop one column from each of the three matrices of dummies, to avoid singularity. However, it is still impossible to estimate this regression because of an additional linear relationship across age, cohort and year. That is, if we decide to label cohorts c as the age of household head in year t = 0 and t refers to the date, we can infer the cohort's age a as

$$a = c + t$$

Therefore, it is necessary to impose another restriction to obtain the normalisation effects. There are several possible alternatives and each of them implies different results. One of the most common imposes the constraint that year dummies coefficients are orthogonal to a time-trend and sum to zero (Deaton and Paxson, 1994). To understand this normalisation, we can consider an example of a variable, say consumption, growing at a 5 percent for each year as for each cohort. This growth can be represented by a time-trend of 5% a year in the year effects, without either cohort or age effects or by age effects that rise linearly with age added to cohort effects that fall linearly with age. Note that these two effects are equal (5 percent) but of opposite sign because cohort are labelled by age at a fixed date, so that older cohort (larger c) are poorer, not richer. In this case, where consumption is the variable to be decomposed, it seems reasonable to attribute growth to age and cohort effects not time, and to use the year effects to capture cyclical fluctuations that average to zero over the long run. The simplest way to implement this normalisation is to estimate the model with the first age group, and the twelfth cohort omitted, so that the reference group is that of a household headed by a 25 year old in 1985. The year dummies are constrained to be orthogonal to a time trend and to

[13] In our case, all matrices have *m* rows, that is the number of cohort-year pairs for each commodity. The number of columns is 51 (the number of ages) for matrix *A*, 62 (the number of cohorts) for *C*, and 12 (the number of years) for *Y*.

add to zero.[14]

We present some results of this decomposition with Figures 3a-3e. We have selected few expenditure categories of our 40-item classification that we consider interesting for this purpose: *fats and oils*, *alcoholic beverages*, *tobacco*, *TV, radio and technical instruments*,[15] and *financial services*. The three food categories showed high values of adult equivalency weights for older age groups and therefore these weights will be possibly driving up the household consumption of these items with the population ageing. The two non-food categories are interesting for the same kind of possible effect but with the opposite sign: their consumption is wide-spreading with technological progress although the elderly today have a low weight in the household expenditure for these items.

For each of these five items, we present four graphs. The first plot shows the average of log consumption for every fifth cohort (from the youngest labelled with number one, born in 1965, to the oldest labelled with number ten, born in 1920). The other three panels show the age effects, the cohort effects (plotted as a function of the age of the household head in 1985), and the year effects, respectively.

The consumption of *fats and oils* is decreasing from the older to the younger cohorts and, according to the age effects, this item is also a decreasing function of age (Figure 3a). The cohort effects decrease at about 3.7 percent per cohort, so that the older is the household the higher is its lifetime profile of consumption for *fats and oils*. The same patterns may be observed for *tobacco*, but here the magnitude of age effects is greater than that of cohort effects (Figure 3b). The awareness of health risks for the consumption of tobacco is more wide-spread as the household head ages rather than as generations change. However, the picture of cohort effects show a steady decline from cohort to cohort with an increase of about 3.5 percent. As for *alcoholic beverages* (Figure 3c), the first panel presents a hump-shaped age profile of consumption. That, in fact, is created by a pure age effect with a peak around the age of 50. Instead, the cohort effects are small and without a distinctive pattern. The year effects for all these categories are smaller than either the cohort or the age effects and they all

[14] Consider d_t as the usual zero-one dummy. To enforce this restriction we have used a set of T-2 year dummies, d_t *, defined as follows, from t = 3, ... T

$$d_t^* = d_t - [(t-1)\, d_2 - (t-2)\, d_1]$$

[15] This category also includes personal computers and cellular phones.

show an economy growing slowly in the 90's, apart from tobacco with a rising profile after 1993.

Financial services are growing from older to younger cohorts at about 3.8 percent per cohort but there is also a great deal of within-cohort variations partly explained by a peak in the year effects in 1989 and 1991 (Figure 3d). The first panel creates an impression of a hump-shaped age profile, which indeed comes from the age effects: according to these, there is less consumption of financial services after age 60 although there is no clear turning down of the profile. Cohort effects are more relevant for *TV, radio and technical instruments* and they decline steadily from younger to older cohorts at a rate of about 4 percent (Figure 3e). The age effects show a more rapid growth between ages 25 and 40, then a slower growth. The year effects present a distinctive hump-shaped profile with a peak in 1991, as we may notice for each cohort segment.

The decomposition of age, cohort, and year effects presented for these selected consumption categories led to mixed results. We wanted to test how "pure" was the age effect implied by the adult equivalency weights estimated in our cross-section analysis, and then used in forecasting. For the food categories, cohort effects are in general not very relevant while the "pure" age effect is dominant in the consumption profile. Therefore, our assumption of using the 1996 weights for the personal consumption expenditures forecasts is not so arbitrary and misleading. However, the other two categories show a decomposition where the generational effects play a distinctive role beside the "pure" age effects. Therefore, this analysis suggests the need to find a procedure to distinguish these effects in forecasting and to project them for the future.

Fig. 3a – Consumption by cohort and its decomposition, 1985-1996: *Fats and Oils*

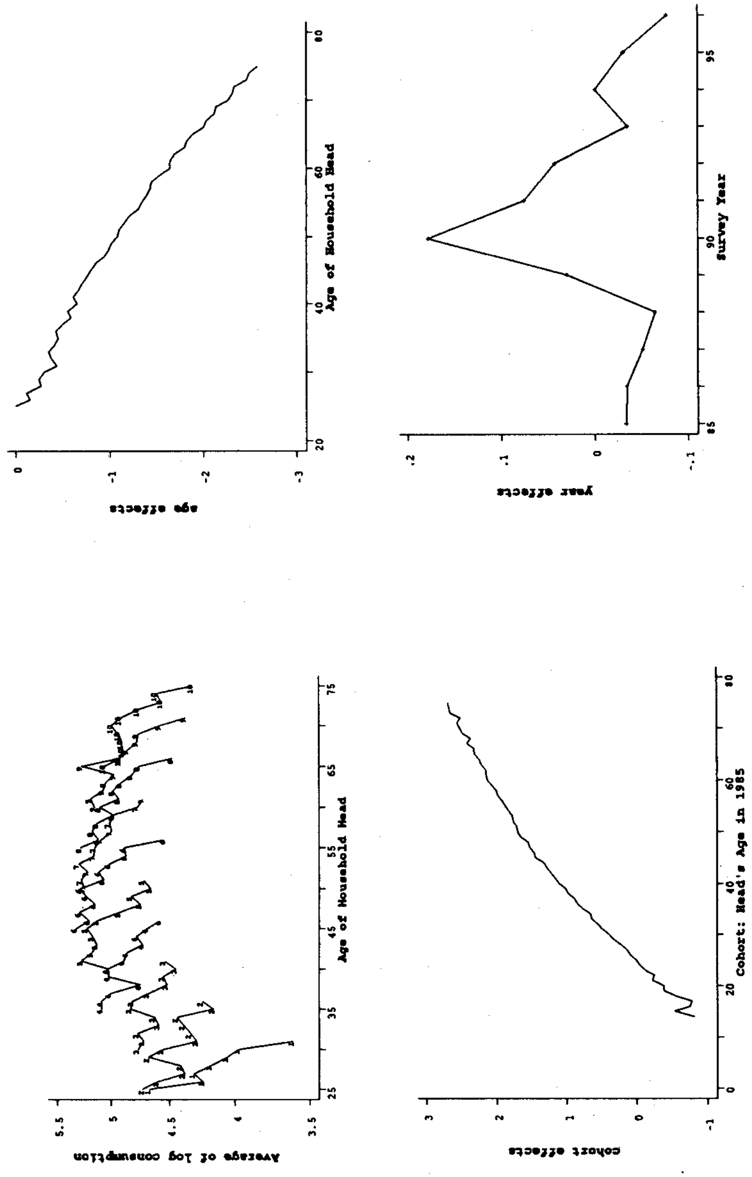


Fig. 3b – Consumption by cohort and its decomposition, 1985-1996: *Tobacco*

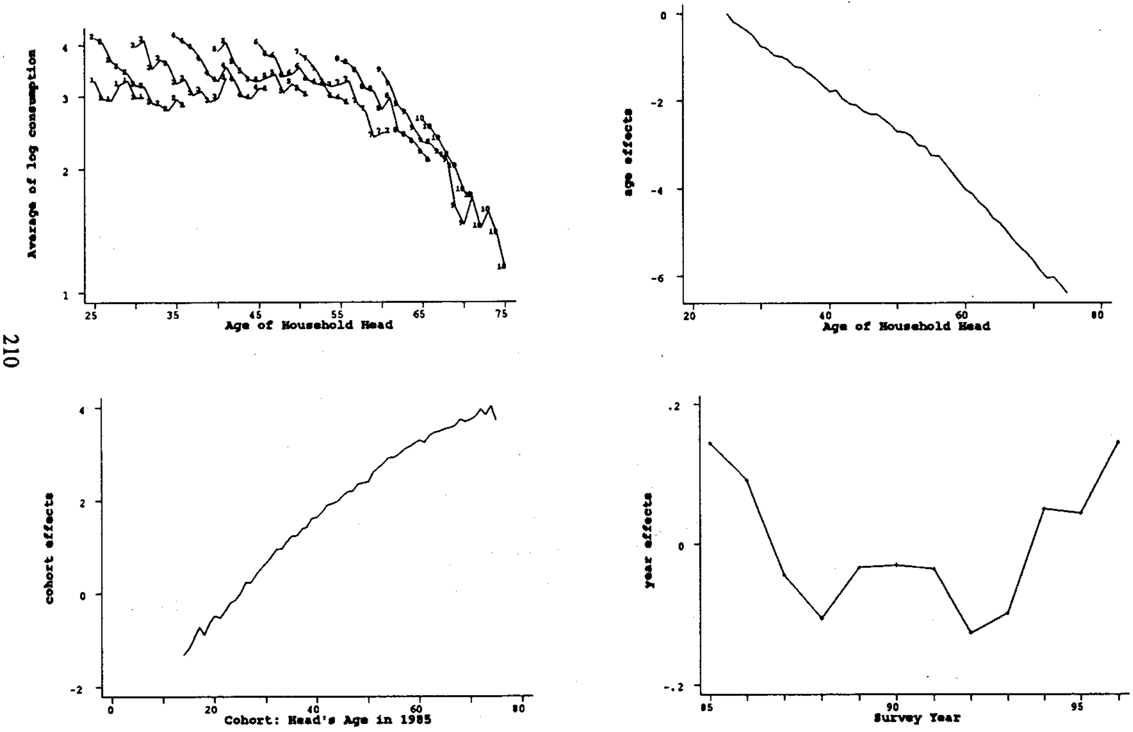


Fig. 3c – Consumption by cohort and its decomposition, 1985-1996: *Alcoholic Beverages*

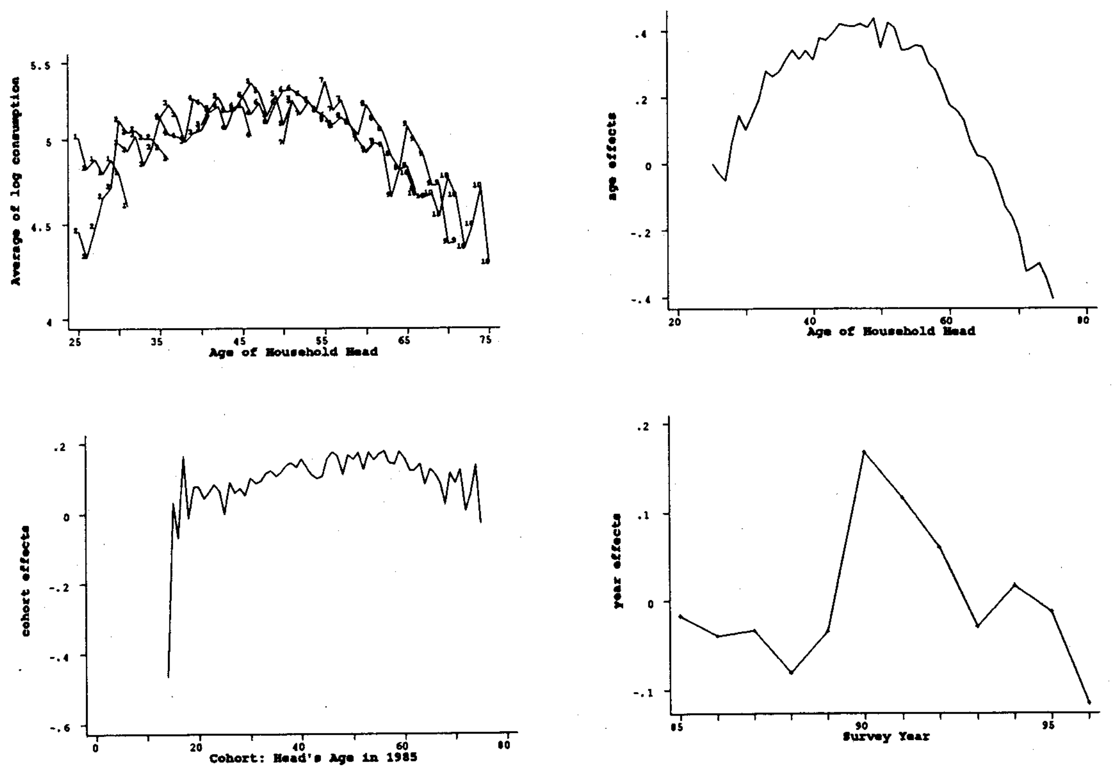


Fig. 3d – Consumption by cohort and its decomposition, 1985-1996: *Financial Services*

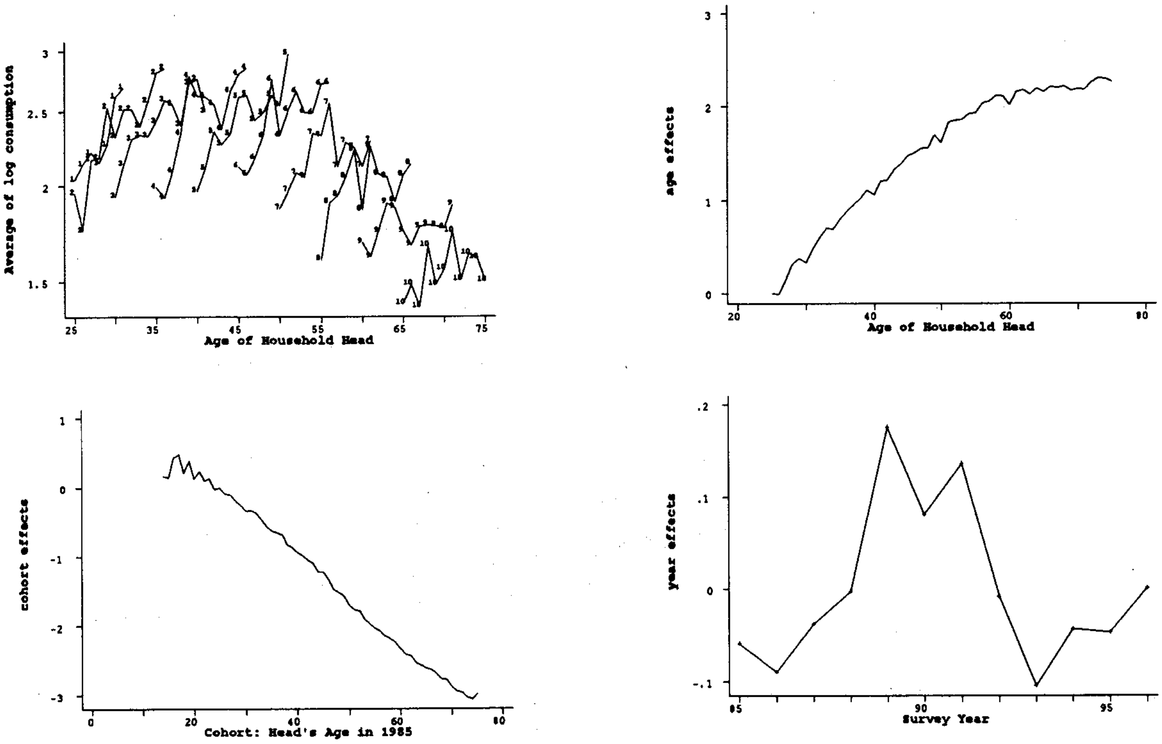
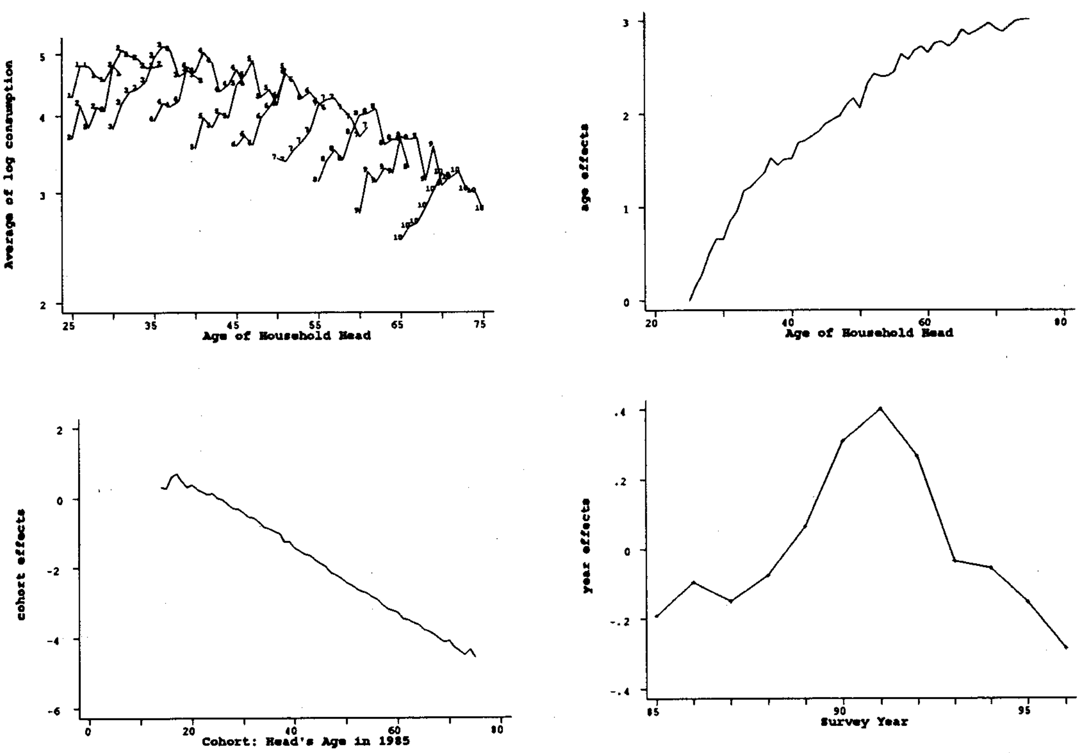


Fig. 3e – Consumption by cohort and its decomposition, 1985-1996: *TV, Radio, and Technical Instruments*



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Appendix A – The cross-section consumption function

The cross-section household consumption function for each item is described as follows:[16]

$$c_{ht} = \left(\sum_{j=1}^{k} x_{hjt}\beta_{jt} + \sum_{j=1}^{m} d_{hjt}\delta_{jt} \right) \sum_{j=1}^{g} n_{hjt} w_{jt} \qquad h=1,\ldots,N \qquad (1)$$

where

c_{ht} : consumption of household h at time t;
x_{hjt} : per-capita income within household h divided in k=10 brackets at time t, j is the bracket index;
d_{hjt} : dummy variable j used to show inclusion of household h in m=15 demographic groups at time t;
n_{hjt} : number of members of household h for g=8 age groups at time t;
β_{jt}, δ_{jt}, w_{jt} : parameters to be estimated for each commodity at time t;
N : number of households in the sample.

The choice of this functional form allows that the Engel curve may represent different types of commodities and estimate different propensities to consume for different income levels. For this purpose a linear spline function has been used: this is a very effective tool to reach an adequate degree of approximation without the function exact specification. A linear spline is a piecewise function in which the linear pieces are joined together in a smooth fashion. By applying this function to design the Engel curve, it is possible to approximate different functional forms according to the commodity type. To do this, income must be divided in brackets, the relationship between income and consumption is supposed linear in each bracket and, through the spline, these linear segments are joined at the knots. This curve is called Piecewise Linear Engel Curve (PLEC).

[16] The description of the cross-section consumption function draw heavily on Bardazzi and Barnabani (1998).

An arbitrary number of brackets is defined whose boundaries (B_L, L=1,...,k-1) are defined such that each bracket contains the same percentage of the total households in the sample (in our case we have designed deciles of the sample). The consumption of household h with a per-capita income Rh in the j-th bracket is:

$$c_{hj} = b_{01} + \sum_{L=1}^{j-1} \beta_{1L}(B_L - B_{L-1}) + \beta_{1j}(R_h - B_{j-1})$$

This equation may be formulated as a standard regression whose deterministic term is

$$c_h = b_{01} + \beta_{11}x_{hl} + \ldots + \beta_{1j}x_{hj} + \ldots + \beta_{1k}x_{hk}$$

where per-capita household income, R_h, is transformed in a vector where each component represents the amount of household income in each bracket. That is, for j=1,...,k:

$$x_{hj} \begin{cases} = B_j - B_{j-1} & if\, R_h \geq B_j \\ = R_h - B_{j-1} & if\, B_j > R_h \geq B_{j-1} \\ = 0 & if\, B_{j-1} \geq R_h \end{cases}$$

The parameters β_{1j} represent the slope of the function for each income bracket: the marginal propensity to consume is not only commodity specific but also different for each income variable.

The demographic variables are included in the cross-section function as zero/one dummies to indicate inclusion of the household in different demographic groups. The effect of these variables in the equation is to shift the Engel curve up or down changing the intercept of the PLEC and no interaction among these demographic characteristics is assumed. The reference household here is a two earners family composed of three or four members and residing in central Italy with a non-college educated household head aged between 35 and 55 working as employee.

The specification of the effects on consumption of per-capita income and household characteristics - the first term in parenthesis of the cross-section equation - allows one to compute for each item the per-capita consumption within the family. To estimate the household consumption it is necessary to deal with the family size. In this case, in order to consider the age composition of the family, we have used the weighted sum of its members: we have estimated a set of weights to express the importance of each household member in contributing to the consumption of a specific item with respect to the reference adult (a 30-39 years old individual). The product of the per-capita consumption by the household weighted size provides the household consumption of each good.

Appendix B - The demographic model: description and hypotheses

The demographic projections model (DPM) used in this study is based upon the "cohort component method" to obtain a population at time t+1 from a base year population and some additional information about the mortality rates from one age to the next, net immigration by age and fertility rates by age.[17] In the long run, it is clear that overall population may be increased by any or all of the following means: a decrease in the mortality rates, an increase in net immigration and in fertility. However, the age composition of the population depends heavily on which of these factors changes and how they change. If we consider a population increase due to an increase of fertility rates and another one explained by a reduction of mortality among the elderly, the age composition of the resulting population would be very different.

With the information about the variables mentioned above, the base year

[17] Several forecasts of Italian population are available. Among them, there are those produced by demographic models designed by Istat, by the Institute for Population Research at CNR (IRP) and by the Ragioneria Generale dello Stato (see Istat (1997), Golini *et al.* (1995), Ministero del Tesoro-RGS (1995), respectively). These models differ for their general characteristics and for the scenario hypotheses.

population is aged one year by adding in net immigration for each age and gender, and applying age and gender specific survival rates to the resulting population. For example, the equation used to predict the number of males aged 30 is the following:

$$male30_{t+1} = male29_{t} * srtm30_{t+1} + 0.5\,(immm29_{t+1} + immm30_{t+1})*(1+srtm30_{t+1})*0.5$$

where male29 is the number of males aged 29, srtm30 is the survival rate for 30 year old males, immm29 and immm30 are the numbers of net immigrants aged 29 and 30. The first term on the right hand side of the equation is straightforward but the second term deserves some further explanation.

We assume that immigrant entry into the country is evenly distributed over the year and that some immigrants (emigrants) are 29 year old when they arrive but will be 30 during the year while others are listed as 30 years old and will still be 30 at the end of the year. Therefore we consider the average of the two years to get effective immigrants of 30 year-olds. Furthermore, since immigrants (emigrants) enter the country having lived at least part of the year already, we have to reduce their exposure to mortality for the year: the term (1+srtm20)*0.5 may be interpreted as the effective survival rate of immigrants, who, on average, enter the country at mid-year.

Finally, we need to obtain a projection of the population of infants by applying the fertility rates by age to each female age group. Summing the births from each age group yields the total number of births. It is necessary to split total births in to male and female. This is done by using the ratio of females to males in the last year available for Italian population. We also calculate life expectancy for age and gender by using the stationary population along with standard demographic techniques. The demographic model also includes a set of equation to estimate the demographic proportions D_j as functions of variables produced by the model and other exogenous variables.

To apply this demographic projections model, it is necessary to make hypotheses about mortality rates, fertility rates and net immigration. At this stage of the study, we have assumed the middle series assumptions - therefore the most likely - expressed and used by Istat for its demographic forecasts (Istat, 1997). As for the mortality rates, Istat has produced estimates with a parametric model: these results indicate that for the future decades the survival of Italians is going to increase along the actual trend. The fertility rates for the future have been produced by assuming a further reduction of fertility by cohort as projected from the recent trend. Migrations have been studied with extrapolative models: the central hypothesis forecasts an influx of about one hundred thousand immigrants until 2000 then a constant entry for the rest of the forecast horizon. Emigrants are supposed to decrease until 2020 and then to remain constant. The hypothesis about the net immigration is the most unpredictable of the components of population projections. The assumption by Istat is based upon the past behaviour but cannot take into account further possible factors that could heavily influence future migrations. The hypotheses summarised above cover the period 1996-2020. For the remaining period to 2050 every demographic component is assumed fixed to its 2020 value.

The demographic projections model permits changing the hypotheses about mortality rates, fertility and net immigration in response to specific policies concerning, for instance, economic incentives for stimulating an increase of births or the variation of the maximum number of immigrants allowed into the country each year. At this stage, in order to test our tool, we did not change these assumption: our scenarios were designed to be as close as possible to those adopted by our National Institute of Statistics.